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The ILLUMINATING ENGINEER

ELECTRICITY · ACETYLENE · OIL · GAS

Edited by LEON GASTER

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OFFICIAL ORGAN OF THE
Illuminating Engineering Society.
(Founded in London 1909.)

Among other articles this number contains:—

The Health of Munition Workers.

The Efficiency of Projectors and Reflectors.

Testing the Light-Reflecting Values of White and Coloured Paints.

Lectures on Illuminating Engineering.

The Lighting of a Cathedral by Semi-indirect Gas Units.

REVIEWS OF BOOKS—UNITS OF BRIGHTNESS—
CONCEALED CHURCH LIGHTING—FLOOD LIGHTING, &c.

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EDITORIAL.

State Aid for Education and Research.

In recent discussions on technical education the need for greater support from the State has often been insisted upon. Only last month we referred to the Memorial addressed to Lord Crewe by the Professors and Staff of the Imperial College of Science, in which great importance was attached to the provision of bursaries in order to check the tendency for gifted youths to drift into blind alley occupations.

We are glad to see that this matter is dealt with in a striking Interim Report issued by the Consultative Committee on Scholarships for Higher Education. The Committee is of a very representative character, the Chairman being the Rt. Hon. Arthur Dyke Acland, whose enthusiasm for the cause of good education is well known.

The terms of reference of the Committee, which was invited to undertake its task in March, 1913, are comprehensive. They cover the whole question of the existing system of awards, whether by Local Education Authorities, by the Governing Bodies of Secondary Schools, Universities and Colleges, by the Trustees of Endowment, &c., for assisting pupils to proceed from Secondary Schools to Universities or other places of Higher Education. It is natural that at the present time the attention of the

Committee has been concentrated chiefly on the making good of deficiencies in regard to scientific and technical training, but the history of the scholarship system as a whole is reviewed, and its proper aims discussed. It is now proposed to remove inconvenient gaps in the educational ladder by providing bursaries which besides covering educational fees will leave sufficient margin to enable boys to disregard the attraction of premature occupation, Another point is the extension of research scholarships for a longer period so that gifted workers may be less apt to relinquish their experiments at the very time when they have acquired facility and expertness. Altogether a sum exceeding £300,000 is suggested for the creation and extension of scholarships of various kinds.

The Report also contains a useful introduction analysing the conditions that have retarded progress in many directions. Manufacturers, it is remarked, have shown a tendency to neglect the work of men of science; the latter, in turn, have perhaps been too disposed to ignore the industrial development of their discoveries. The gap between practice and theory between pure and applied science, needs to be bridged. "There are three needs; a need for pure science; a need for applied science; and a need for a more generally diffused interest in the principles and results of science."

This statement entirely bears out what has been said in recent issues regarding the need for co-operation between the State and the press. For the press, particularly the section of it which deals habitually with scientific and industrial matters, offers one of the most potent instruments for bringing about the required diffusion of interest in scientific methods and might become a most valuable channel for the dissemination of information amongst manufacturers and the general public.

The need for immediate action is evident, and we hope that the Report of the Consultative Committee will be promptly acted upon. It must not be supposed that while we are discussing this subject other nations are standing idle. The widespread interest in the organisation of science and industrial research is aptly illustrated by an article in the last number of the *General Electric Review*.* It is worthy of note that in 1914 the American Association for the Advancement of Science appointed a committee of one hundred to promote co-operation between the industries and universities. The recently introduced Senate Bill (4874) deals with the establishment of an engineering or mechanic arts experiment station in each State or Territory, a popular feature being the issue of regular bulletins and reports of progress at Government expense.

The proposed Federal Institute of Science and Industry in Australia we have already mentioned in these columns and we notice that in Canada a scheme for promoting scientific and industrial research is also under consideration.

Finally, we note the interesting statement that the Japanese Government has recently set aside a sum equivalent to £200,000 for the establishment of a laboratory for physical and chemical research, and that the Emperor has contributed an additional £100,000.

Britain, therefore, must guard against the supposition that the efforts she contemplates making will not be duplicated in other countries and at the present moment it is particularly vital that the Government should keep in touch with and encourage co-operation with the organisations which will doubtless be built up throughout the Colonies and Dominions.

* Research Organisation, by W. R. Whitney, *Gen. Electric Review* (of America), July, 1916.

Lectures on Illuminating Engineering.

On page 222 in this issue will be found an announcement of the series of lectures on illuminating engineering to take place at the Pennsylvania University, on the occasion of the Tenth Annual Convention of the American Illuminating Engineering Society, to be held next September. The lectures are organised by the Society working in co-operation with the University. A very varied list of subjects has been selected and each lecture will be delivered by a specialist.

It is now six years since a similar course was arranged at the Johns Hopkins University, Baltimore, in 1910, and we are glad to see that this successful experiment is to be repeated. During the intervening period illuminating engineering has made great strides from theory to practice. At the time when the Johns Hopkins course was held the movement was concerned mainly with fundamental principles and the lectures were accordingly devoted chiefly to ideas and methods. Since then the number of workers engaged in the investigation of lighting problems has very much increased, and the experience of the past six years has served to crystallise existing knowledge. We anticipate, therefore, that the forthcoming series of lectures will form a valuable summary of the present practice in various fields of lighting.

In this country the present circumstances are naturally unfavourable to the organisation of such lectures on a large scale. The great majority of the younger men, by whom they would ordinarily be attended, are absent with the forces, and many of those whose assistance as lecturers would be desirable have other urgent claims on their services in connection with the war. It will be recalled that a start was made in 1911 by the arrangement of three simultaneous courses on illuminating engineering at various educational institutions in London, and since then special courses have from time to time been organised by members of the Society at their respective colleges. In the future, however, we hope that such lectures will be much more fully developed.

The present revival of public interest in education and science should pave the way for greater activity in the field of illuminating engineering and we have no doubt that a proper place will be assigned to this subject at the great institutions whose scientific work, already of considerable value, is destined to be extended in the near future.

This matter is one for the Illuminating Engineering Society to take up with the educational authorities at the proper time. But there are many opportunities for effort on the part of individual companies and institutions. We have quoted examples of the growing recognition of the need for fostering a belief in scientific method amongst the general public. In illuminating engineering, the case for such effort is particularly strong. Companies engaged in the supply of gas and electricity, and manufacturers concerned with the production of lamps and lighting appliances depend for their prosperity on gaining the goodwill of the commmunity. In order to extend their activities in the manner we hope and expect after the war, they should now be considering how best to train their staff to a higher degree of technical efficiency, how best to bring home to the public the value of their services, and, last, but not least, how they can combine and co-operate in order to carry out these aims.

The "Lumen" as a Basis of Comparison for Illuminants.

During recent years the practice of basing comparisons of various types of lamps and illuminating engineering calculations on the conception of flux of light, has made great progress. The Lumen, originally proposed by Professor Blondel at the International Electrical Congress at Geneva in 1896, has now become a much more familiar unit to lighting engineers, largely through the energetic popularisation of the term by our friends in the United States.

The relative merits of the "candle" and the "lumen" were debated at a meeting of the Illuminating Engineering Society in this country in 1914, corresponding members on the Continent and in the United States freely expressing their views. The general impression at that time was undoubtedly that the expression of illuminating power in terms of lumens is the more accurate and scientific method, but that the candlepower being now a well-understood and familiar term, could not be readily displaced. While, therefore, scientific men are turning towards the use of the lumen for accurate comparisons, we must in dealing with the general public, undertake an educational campaign in order to achieve the desired alteration gradually.

In comparing different types of lamps, having widely divergent polar curves of light-distribution, it has long been recognised that the plan of merely stating the light in some particular direction is quite unsatisfactory, especially now that so many different types of lamps are in use. There is much to be said for basing such comparisons on the total output of light in all directions, and once this is recognised, there seems good reason to adopt the more scientific method of specifying the flux of light.

At the last meeting of the National Electric Lamp Association in the United States the question of rating electric lamps in lumens was seriously discussed, and a recent article note in the *Electrical World* makes some comments on the subject. The remarks are substantially in accordance with the views expressed above.*

We understand that some of the manufacturers in this country are already introducing the lumen-basis in their lists. This is an enterprising progressive step. We should, however, like to suggest that for some time to come it would be advisable to state side by side both the flux of light in lumens and the consumption and candlepower values of the lamps as originally presented in catalogue literature. In this way the term "lumen" will gradually become familiar and at the same time its connection with the candlepower will be better understood.

We may also draw attention to another application of the flux of light basis of nomenclature, namely in connection with brightness-values. The specification of brightness was also discussed at the meeting of our Society in 1914 and arguments were advanced for and against the methods of expressing brightness in terms of "candlepower per square inch" and "equivalent foot-candles." It is now proposed to express the luminosity of all objects, whether self-luminous, or made visible by reflected light, in terms of lumens per unit area. With this object in view the Illuminating Engineering Society in the United States suggests as a unit the "lambert" which is the brightness of a surface emitting one lumen per square centimetre. The "lambert" is already finding its way into American literature and we give on p. 224 an explanation of this term.

L. GASTER.

* *Elec. World*, July 1st, 1916.

THE CONDITIONS OF HEALTH OF MUNITION WORKERS.*

Since the outbreak of war the conditions of health of munition workers have been the subject of much concern. In the rush of equipping and staffing new factories many unforeseen problems arose and much valuable experience has been gained. It can hardly be doubted that this experience will have a favourable influence on the condition of workers generally after the war, and the whole question affecting, as it does, the future industrial welfare of the nation, is of great importance. In this article we are, therefore, giving a summary of some of the chief points in the publications of the Home Office and the Ministry of Munitions bearing on this point. The question of lighting, it will be recalled, was dealt with specially in the Report of the Departmental (Home Office) Committee, issued in the autumn of last year. Since that date the Committee appointed by the Ministry of Munitions on the Health of Munition Workers has issued a series of valuable bulletins, in which the whole subject is surveyed in a very practical manner. Many of the problems involved such as the conditions determining industrial fatigue, have a close relation to lighting problems and those interested in industrial illumination would do well to keep themselves informed of the progress in the study of industrial hygiene in its broader aspects.

The series of bulletins issued by the Ministry of Munitions Committee deals with the following subjects :—(1) Sunday Labour, (2) Welfare Supervision, (3) Industrial Canteens, (4) Employment of Women, (5) Hours of Work, (6) Canteen Construction and Equipment, (7) Industrial Fatigue and its causes, (8) Special Industrial Diseases, (9) Ventilation and Lighting of Munition Factories, (10) Sickness and Injury. Attention may also be directed to a Report by Mr. A. F. Stanley Kent on " An Investigation of Industrial Fatigue by Physiological Methods," issued by the Home Office in 1915.

* Bulletins Nos. 1—10 issued by the Health of Munition Workers' Committee (Ministry of Munitions), London, 1915—1916.

Sunday Labour.

The problem of Sunday labour is of great importance in relation to physical and mental fatigue. " Not only must one consider the long hours of labour and the prevalent over-time, the environment of the work and the physical labour involved, but also the mental fatigue and boredom resulting from continuous attention to work." Supervision is difficult and imposes a severe strain on the foremen, constant Sunday work means high wages and bad time-keeping during the week, and there is considerable feeling that one day's rest in seven is good for body and mind.

In the case of women and young children the evils are accentuated. If employment in emergencies on Sunday cannot be avoided it is suggested that operators should not be at work on two consecutive Sundays, should have time off on Saturday, and should be employed for a portion of the day only. Even in the case of men it is recommended that Sunday work should be confined to sudden emergencies, such as the making up of occasional arrears in certain sections, and the undertaking of repairs, tending furnaces, &c., the men being given a corresponding rest during some part of the week.

Employment of Women.

In the case of women the problem is complicated by the fact that they have, in many cases, home duties which cannot be neglected. The question of transit facilities (also mentioned under the heading of " welfare supervision ") is most important. A day beginning at 4 or 3.30 a.m. for work at 6 a.m., followed by 14 hours in the factory and another

two or two and a half hours on the journey back, may end at 10 or 10.30 p.m. "Beds are never empty and rooms are never aired, for in a badly-crowded district, the beds, like the occupants, are organised in day and night shifts. In such conditions of confusion, pressure and overcrowding, home can have no existence." Night-work, in the case of women, is particularly objectionable, as their sleep is inevitably subject to frequent interruptions during the day.

Welfare Supervision.

Such conditions lead one to appreciate the benefit of "welfare supervision," *i.e.*, the appointment of a staff whose sole duty it is to inquire into the welfare of employees. Among the duties of such a staff are included the registering of available houses and lodgings for employees, inquiry into means of transit and the need for fuller facilities, management of canteens, investigation of sickness, sanitation and hygiene, recreation and educational work, &c. Experience shows that the organisation of welfare supervision has a vital effect both on the health of workers and on the quality of work.

Canteen Construction and Equipment.

The question of canteen construction and equipment is discussed in two separate bulletins (Nos. 3 and 6), and practical suggestions are made for the preparation of wholesome food at a reasonable cost. In the rush of work operators are rarely in a position to prepare their own meals satisfactorily, and the time spent in getting food outside the factory during the mid-day interval is an important consideration. We are glad to note that it is laid down that "the effective cleanliness, warming (55—60 degrees), lighting and ventilation should receive careful attention and be properly and continuously maintained." Good lighting, natural and artificial, is an important factor in making the canteen attractive. Ample access of daylight is desirable, and it is suggested that the total window-area should in no case be less than one-tenth of the floor area.

Overtime and Night-work.

On the subject of hours of work reference is again made to the effect of overtime, particularly in the case of operators engaged in highly-skilled work (tool and gauge-making, tool-setters, &c.) who have frequently had to work long hours. Even at the time this report was issued 70—80 hours a week were still frequent, and in the early stages of the war as much as 90 hours was not uncommon. "The Committee are satisfied that if men are asked to work for 15 hours a day for weeks and months on end one of two results must follow: either the health of workers will break down or they will not work at high pressure." The view has been expressed that a 65-hour week, with a maximum of 80 hours in any one week was as much as men ought to be asked to work. If overtime is resorted to there should be no Sunday work.

The length of the night-shift should never exceed that of the day-shift. Night-work is regarded as uneconomical because the output during the last two or three hours of the twelve is usually low; supervision is difficult; workers find a difficulty in accommodating themselves to the practice of sleeping in the day-time, and to the unfamiliar meal times; finally conditions of lighting by night are seldom so good as in the day-time.

Industrial Fatigue.

The effects of overtime work are again mentioned in the Bulletin on Industrial Fatigue and its Causes (No. 7). In this connection the Report of Mr. Stanley Kent, mentioned above, is interesting as showing how the effect of fatigue can be demonstrated by actual tests. These include examination of the power of doing work (ergograph), muscular sense, central nervous system, including time of response to signals, acuity of vision and hearing, &c., and the circulatory system. The tests show quite clearly how a progressive fatigue occurs during the week, and how improvement follows the nightly period of rest. It is an interesting question how far such tests could be applied to determine the effect of poor lighting con-

ditions in causing fatigue. The principle of arranging prescribed periods of work followed by appropriate intervals for relaxation goes to the root of scientific utilisation of labour. It seems reasonable to suppose that in many cases the amount of work done during a given period could be greatly increased by careful attention to this point.*

It is acutely remarked: "It is not surprising that where employers, following tradition rather than experiment, have disobeyed physiological law in the supposed interests of gain, and for a century this has been almost universal—the workers have themselves fallen very commonly into a tradition of working below their best during their spells of labour"—a slowing down that is really a kind of physiological self-protection.

The bulletin also refers to the prevalence of accidents and spoiled work, sickness, lost time, and "staleness" following fatigue.

Some interesting examples of intelligent management are given:—

In a shell factory the men in the early hours of the war worked seven 12-hour day and seven 12-hour night-shifts during the week. More recently arrangements have been made to give every man a weekly day of rest, and the men work from 6 a.m. to 7.30 a.m., with half an hour for breakfast and an hour for dinner. Yet an increased number of shells is being produced from half the number of workers.

At another large munitions factory the management insisted on a rest of 15 minutes in every hour of work. The men, being on piecework, at first objected, thinking that their output would be diminished. But when the rest was rigidly adhered to they found that the output per hour was actually increased.

In a third case girls engaged in monotonous repetitive work were given a break of 15 minutes in the open air at 11 a.m. In spite of this deduction from the working hours the output per day was increased.

In conclusion it is remarked:—

"Even during the urgent claims of war time the problem must always be to obtain the maximum output from the individual worker which is compatible with the maintenance of health. In war time the workmen will be willing as they are showing in so many directions, to forego comfort and to work nearer the margin of accumulating fatigue than in time of peace, but the country cannot afford the extravagance of paying for work done during incapacity from fatigue just because so many hours are spent upon it, or the further extravagance of urging armies of workmen towards relative incapacity by neglect of physiological law."

* An incident at the front is of great interest in this connection. Two officers, for a wager, competed in making equal lengths of a certain trench, each with an equal squad of men. One set his men to work as they pleased, but as hard as possible. The other divided his men into three sets to work in rotation, each digging their hardest for five minutes and then resting for ten, till their spell of labour came again. The latter team won easily.

Sickness and Injury.

Bulletins Nos. 8 and 10 deal respectively with "Special Industrial Diseases" and "Sickness and Injury." Among the former are included various dangers incidental to munition work, such as lead-poisoning and the effects of fulminate of mercury, tetryl, tri-nitro-toluol, &c.

Among causes of sickness and injury are mentioned excessively long hours of work, particularly at night, cramped postures and constrained attitudes during work, muscular strain, machinery accidents, poor ventilation, imperfect lighting whether by day or night (which conduces to eyestrain and headaches), noxious gases and vapours, dust produced in various processes, &c.

The careful supervision of the sick-rate, and the provision of proper methods of detecting early indications of sickness and securing prompt medical attention for same, are insisted upon. The study of the sickness rate is a most important guide to defective conditions. A case is mentioned of a large munitions works in which the sickness rate increased progressively from 2.4 to over 4 per cent., while the accident-rate also rose. Among men on overtime work the sickness rate was in one case 5.5 as compared with 3.7 among those on double shifts. Overtime and night-work seem to be common explanations of a rising sickness rate.

The data for accidents and first-aid supply confirmatory evidence. Thus in one works during the autumn of 1914, when the hours of work were from 8 a.m. to 5.45 p.m. an average of 100 first-aid dressings were done each month per 1,000 employed; in 1915 for the same period of the year, when the hours of work were from 8 a.m. to 8 p.m., the average rose to 292, and at night, when the hours of work were from 8 p.m. to

8 a.m., to 508. This increase is attributed to: (1) longer hours, (2) more thorough organisation of first-aid treatment, and (3) the fact that a greater proportion of the workers are engaged at night employed on machines as compared with daytime.

The above data are of particular interest to readers of this journal, in view of the stress laid on the extra difficulties, both as regards fatigue and accidents, of persistent night work. It is highly probable that this is due in part to the fact of the conditions of illumination being less satisfactory than those prevailing in the day-time, and it will be observed that this fact is specifically mentioned by the Committee in Bulletin No. 5 on Hours of Work (p. 8). Defective lighting is also mentioned in Bulletin No. 10 (Sickness and Injury) as conducive to eyestrain and headache. Many of the other causes of sickness are, no doubt, also connected with lighting defects. Thus machinery accidents are increased by poor lighting, as the machine is less carefully tended and therefore apt to break down, and employees may endanger their life through inability to see machinery clearly. Insufficient light on the work or glare no doubt adds to the strain of work, accentuating fatigue, while badly-placed lamps giving inconvenient shadows lead to workers adopting cramped positions.

VENTILATION AND LIGHTING.

In Bulletin No. 9 on Ventilation and Lighting of Munition Factories, ventilation, heating, and lighting are discussed in some detail. It is pointed out that the desirable atmosphere in workshops should be :—

(*a*) Cool rather than hot.

(*b*) Dry rather than damp.

(*c*) Diverse in its temperature in different parts and at different times rather than uniform and monotonous and (which is intimately connected with this diversity)

(*d*) Moving rather than still.

In dealing with Lighting the Committee have naturally taken note of the Recommendations in the Report of the Departmental Committee on this subject, and comment on this subject as follows :—

IV.—LIGHTING.

12. This question has been treated with thoroughness and care in the Report of the Departmental Committee on Lighting in Factories and Workshops,* which has recently been published, and little more is necessary than to refer briefly to the main conclusions of that report.

The essentials of good lighting are there summarised as :—

(*a*) Adequacy.

(*b*) A reasonable degree of constancy and uniformity of illumination over the necessary area of work.

(*c*) The placing or shading of lamps so that light from them does not fall directly on the eyes of an operator when engaged on his work or when looking horizontally across the workroom.

(*d*) The placing of lights so as to avoid the casting of extraneous shadows on the work.

13. Natural lighting is to be preferred to artificial lighting on grounds of health as well as of economy. Where it can be arranged, roof lighting is generally to be preferred to lateral lighting. In a good system of roof lighting the illumination is very uniform. In modern factories where lateral lighting is employed a large part of the walls are devoted to windows, but it is evident that there is a limit to the width of the room, beyond which the illumination falls below what is adequate; what this width is will depend partly on the nature of the work to be done in the shop and partly on the extent to which the light is impeded by outside obstacles such as neighbouring buildings or inside obstacles such as machinery.

14. The effect of light-coloured walls and white ceilings on the general brightness of the room and in affording an effective background to dark objects should not be overlooked. In some cases the natural lighting may be improved by deflecting vertical light into the room by means of reflectors or prismatic glass, or by whitening the surface of an external wall or building which obstructs the light. The position of permanent working points should be so adjusted in relation to the windows and to internal obstructions of whatever kind as to secure, so far as practicable, adequate daylight for each.

15. The necessity for the regular cleaning of windows on the inner and outer surfaces cannot be too much insisted on. Not only do dirty windows prevent a large proportion of daylight from entering the shop, but the daylight period of work is considerably shortened and needless expenditure on artificial lighting incurred in consequence. At the present time the anti-air raid darkening regulations have much intensified this loss of natural light. In the construction of shops care should be taken to render the out-

* First Report of Departmental Committee on Lighting in Factories and Workshops, 1915 (Cd. 8,000).

sides of windows easily accessible for cleaning. In many existing shops access is so difficult as to make cleaning almost impossible.

16. The question of artificial lighting is of special importance at the present time, when night work is general, and when women and boys are employed in large numbers. Bad lighting affects output unfavourably, not only by making good and rapid work more difficult but by causing headaches and other effects of eye-strain; the difficulties of supervision, which are always considerable, are further increased if the general lighting of the workshops is insufficient.

A factory may be instanced where in one shop the ceiling was uniformly whitened and illuminated by arc lights which were shaded from the workers. The shop was illuminated by an agreeable diffuse light which cast no shadows. To produce the best effect the entire top surface can be covered with sheets of metal and enamelled white. Such a method of lighting may prove to be more costly in upkeep, but it has compensatory advantages in promoting the health of the workers and thus may prove to be economical in the long run. In an adjoining shop the lighting was carried out by electric lamps each suitably shaded to throw light down on the lathe, and not on the eyes of the workers. In still another shop of the same factory fish-tail gas burners were in use, the lighting by such means being very poor and quite unshaded. Owing to the impoverished illuminating power of gas its use without incandescent mantles is to be condemned. Excellent lighting is obtained by the use of incandescent mantles and gas under pressure. The lamps in lofty shops can be placed high up so that they shed a diffuse light without directly throwing a glare into the workers' eyes.

17. Attention should be paid to the lighting of the passages and immediate surroundings of the factory as well as to that of the workshops themselves. In the Report of the Departmental Committee, standards of lighting for factories are suggested, and though the figures given are the minima considered necessary, they may, at any rate, prove of assistance in suggesting the relative amount of light necessary in different parts of the factory.

ENGINEERING EDUCATION AND RESEARCH.

A valuable Report on this subject was recently prepared for the Council for Organising British Engineering Industry by Mr. A. P. M. Fleming (*Superintendent of Insulation and Transformer Depts., Brit. Westinghouse Elec. and Manufacturing Co.*), Prof. C. J. Maxwell Garnett, M.A. (*Principal of the School of Technology and Dean of the Faculty of Technology in the University of Manchester*), and Prof. Miles Walker, M.A., M.I.E.E. (*Professor of Elec. Eng. in the School of Technology and in the University of Manchester*).

A distinction is drawn between the training of manual workers and thinkers in industry. Workers, after passing through the public elementary school, should proceed to a junior technical school, where they can be specially educated with a view to their industrial employment (somewhat on the lines of the methods of Osborne school for the navy). At the age of fifteen they should enter work as apprentices, and their course of training should include lectures and instruction, besides works experience. Specially gifted youths should be selected for higher training at universities.

Much greater facilities are also needed for university courses for engineers intended to occupy higher positions in industry. Additional scholarships are required and the arrangements at different training centres and towns should be made more uniform. At present a boy's chance of winning a scholarship depends greatly on the local educational endowment, in fact on the town in which he happens to live.

Suggestions are also made for the better organisation and application of research, for which a central institution is needed.

Apart from its practical value to industry, research acts as a valuable educational element. "The personal influence of the man doing original work in his subject inspires belief in it and awakens enthusiasm and gains disciples. It is by associating students throughout their university careers with such men that their own latent originality is best developed."

STATE AID FOR RESEARCH AND TECHNICAL EDUCATION.

THE Interim Report just issued by the Consultative Committee on Scholarships for Higher Education (Board of Education Cd. 8291) makes a number of suggestions for stimulating the pursuit of scientific knowledge and industrial research.

During the last forty years scientific and industrial research has admittedly not made the progress in this country which modern conditions demand. Common sense, energy, voluntary effort, spontaneous enterprise were responsible for the great industrial progress of Britain in the first part of the last century. But after the war of 1870 a new era, based on the methodical application of scientific knowledge and method began, and here we have temporarily fallen behind. The development and application of scientific effort has been less complete and the relation between industry and science has not been satisfactory. Business men have considered scientific workers unpractical; men of science have not secured from industry the necessary encouragement and incentive to effort. This gap between requires to be bridged.

Since the outbreak of war an important step in this direction was taken in the appointment of the Committee of the Privy Council on Industrial Research. Efforts are also being made to ascertain and remedy defects in the present system of education. The Report contains an analysis of the functions of Elementary, Lower Secondary and Junior Technical Education, a special reference being made to the need for further development of the Trade Continuation Schools. There is a great gap between in the educational development of children after leaving school, and able youths drift into blind alley occupations, merely in order to earn immediate wages. To correct this tendency it is proposed to award to gifted boys scholarships and bursaries sufficient to cover the fees of education in important branches of trade and also to remove the temptation of seeking immediately remunerative but ultimately undesirable employment.

In addition to this additional scholarships at Technical Institutions and Universities are suggested, and it is mentioned that the sum at present allotted to in this way is only about one-sixth of that provided in Germany.

Simultaneous with the fostering of education, opportunities for the employment of those so educated should be developed; otherwise there is a danger of the situation which at one time arose in Germany, where there existed a surplus of educated workers unable to find suitable employment and forming a discontented element in the population.

It is therefore necessary to proceed with caution. But at present the lack of sufficient scientifically trained men in this country is so manifest that there is ample scope for encouragement of such education. It is therefore proposed that the following sums should be set aside for this purpose:—

	£
For strengthening the higher parts of selected Secondary Schools	100,000
For maintenance grants to Scholars to enable them to receive Higher Secondary Education from 16 to 18 or 19 ..	90,000
For Government Scholarships from Secondary Schools to the Universities, &c., in Scientific and Technical subjects ..	67,000
(For the additional cost of such Scholarships if held at Oxford and Cambridge)	10,000
Grants in aid of Local Authorities for Scholarships to Universities from Secondary Schools ..	25,000
For Scholarships from Senior Technical Schools, &c., to the Universities	27,000
For prolongation of Scholarships at the Universities for training in Research	20,000
	£339,500

COMMITTEE OF THE PRIVY COUNCIL FOR SCIENTIFIC AND INDUSTRIAL RESEARCH.

STANDING COMMITTEE ON ENGINEERING.

The Standing Committee on Engineering appointed by the Advisory Council for Scientific and Industrial Research held its first meeting on Wednesday, 7th June. The Committee has been so constituted as to represent both the scientific and the industrial sides of engineering, and includes the following members nominated by the Professional Associations:—

Institution of Civil Engineers, Sir Maurice Fitzmaurice, C.M.G.; *Institution of Electrical Engineers*, Mr. J. S. Highfield; *Institution of Mechanical Engineers*, Dr. Dugald Clerk, F.R.S.; *Institution of Naval Architects*, Sir Archibald Denny, Bt.; *N.E. Coast Institution of Engineers and Shipbuilders*, Mr. Herbert Rowell; *Manchester Association of Engineers*, Mr. Alfred Saxon; *Institution of Engineers and Shipbuilders in Scotland*, Mr. James Brown; and the following members directly by the Advisory Council:—

Mr. F. R. Davenport, Mr. Alfred Herbert, Professor Bertram Hopkinson, F.R.S., Mr. C. H. Merz, Mr. V. L. Raven, Mr. A. A. Remington, Mr. G. Gerald Stoney, F.R.S., Mr. Douglas Vickers, Professor Miles Walker.

The Advisory Council have appointed Sir Maurice Fitzmaurice, C.M.G., to be chairman.

The Committee was welcomed by Sir William M'Cormick, Chairman of the Advisory Council, and Dr. H. F. Heath, Administrative Secretary of the Council. Sir A. Selby-Bigge, Secretary to the Committee of the Privy Council for Scientific and Industrial Research, also attended and emphasised the importance attached by the Government to the need for greatly increased activity in research in connection with industry. In Sir Maurice Fitzmaurice's opening statement as Chairman of the Standing Committee several important aspects of the Government Scheme as issued in July, 1915, were referred to, and attention was directed in particular to the necessity for securing that British industries shall get as large a share as possible of the full value of the results of any successful researches and shall retain at least the initial advantages derived from them. He felt in this connection that the Committee would be in a position to advise the Government organisation for Research as to the means of securing that their operations should yield the maximum benefits to the trade and industry of the Empire. Applications for aid must be dealt with on as broad lines as possible, without red-tape and with a constant regard to the ultimate object of the Government Scheme which is to help the industrial community of the Empire in the contest with the common trade enemy. It would be of great value that applicants for assistance to researches should make it clear at the outset whether results if obtained should be considered as of a confidential nature, as in arranging our experimental work we must avoid conditions calculated to help foreign competitors. Much time and money had been spent upon research in the works of individual firms whose aggregate expenditure for the purpose far exceeded the sums at the disposal of the Committee of Council, and from the industrial side such work by firms appealed to him as the most hopeful arrangement. But the Government had made a decided step forward by showing their interest in industrial research, and though he expected much more from the scheme, the gain would be great if the only result were the training of research workers. Too much must, however, not be expected from research and experimental work in themselves, for these alone would not win back the industries which should never have left us or even retain those we still possessed. Though it was not for the Standing Committee to deal with such questions, individual and combined efforts were needed to secure that the products of this country find their way to those who need them at home and abroad, and to see that what is wanted is supplied by our industries. Sir Maurice Fitzmaurice hoped that it would be possible to co-operate with our fellow-countrymen beyond the seas in carrying out many useful investigations.

ILLUMINATING ENGINEERING LECTURE COURSE AT PHILADELPHIA.

Under the joint auspices of the Illuminating Engineering Society (U.S.A.) and the University of Pennsylvania.

It will be recalled that in 1910 a lecture course was arranged by the American Illuminating Engineering Society in co-operation with the Johns Hopkins University, at Baltimore, U.S.A. This course was devoted mainly to the *science* of illumination. It is now proposed to hold a series of lectures in Philadelphia, as mentioned above, which will deal chiefly with the *art* of illumination. The course will include about twenty lectures by specialists, and will be supplemented by an exhibition, at the University of Pennsylvania, of the latest developments in lamps, lighting appliances, photometers, &c. Visits will also be arranged to various manufacturing works, laboratories, lighting companies and notable installations.

The following is the preliminary list of subjects for lectures :—

SUBJECTS AND LECTURERS.

(A)—*General*—

(1) Illumination Units and Calculations, A. S. McAllister.
(2) Modern Photometry : Clayton H. Sharp.
(3) The Principles of Interior Illumination (two lectures) : Committee, J. R. Cravath, Chairman.
(4) The Principles of Exterior Illumination : Louis Bell.
(5) Colour in Lighting : M. Luckiesh.
(6) Architectural and Decorative Aspects of Lighting : Guy Lowell.
(7) Recent Developments in Electric Lighting Appliances : G. H. Stickney.
(8) Recent Developments in Gas Lighting Appliances : R. ff. Pierce.
(9) Modern Lighting Accessories : W. F. Little.

(B)—*Lectures on Interior Illumination*—

(10) The Lighting of Factories, Mills and Workshops : C. E. Clewell.
(11) The Lighting of Offices, Stores and Shop-windows : N. Macbeth.
(12) The Lighting of Schools, Auditoriums and Libraries : F. A. Vaughn.
(13) The Lighting of Churches : E. G. Perrot.
(14) The Lighting of the Home : W. H. Jordon.
(15) Railway Car Lighting : G. E. Hulse.

(C)—*Lectures on Exterior Illumination*—

(16) Street Lighting (two lectures : (a) P. S. Millar ; (b) C. F. Lacombe.
(17) The Lighting of Yards, Docks, and Outside Works : J. L. Minick.
(18) Headlights, Searchlights and Projectors : E. J. Edwards.
(19) Sign Lighting : L. G. Shepard.
(20) Exhibition and Pageant Lighting : W. D'A. Ryan.

ILLUMINATING ENGINEERING SOCIETY (U.S.A.).

Tenth Annual Convention.

We are informed that the following list of subjects has been approved by the Papers Committee for the coming Tenth Annual Convention of the American Illuminating Engineering Society, to be held in Philadelphia next September :—

Coloured Glasses for Illuminating Engineering, by Dr. H. P. Gage.

Lighting of Cleveland Museum of Art, by Dr. E. P. Hyde.

Illuminating Engineering Photographs, by B. H. Norris.

Some New Phenomena of Persistence of Vision, by Dr. H. E. Ives.

The Effects of Brightness and Contrast on Vision, by Dr. P. G. Nutting.

Apparent Brightness and its Properties, by Dr. L. T. Troland.

Integrating Spheres, by F. A. Benford.

Street Lighting, by Ward Harrison.

Gas and Electric Lighting in the Home, by C. H. French and C. J. Van Gieson.

Optic Projection as a Problem in Illumination, by J. A. Orange.

Forced Life Testing of Incandescent Lamps, by L. J. Lewinson.

THE EFFICIENCY OF PROJECTORS AND REFLECTORS.

By Haydn T. Harrison, M.I.E.E.

(Abstract of Paper read before the Liverpool Engineering Society, February 23rd, 1916.)

An interesting paper on the above subject was read before the Liverpool Engineering Society on February 23rd, Professor E. W. Marchant in the chair. In his introductory remarks, Lieut. Harrison, R.N., explained that he had lately conducted a series of researches on search-lights in connection with his work in the Navy, but was not at liberty to refer to them in detail.

The effective range of search-lights is chiefly a matter of obtaining the maximum candle-power in the direction of emission, *i.e.*, of diminishing the angular spread of the beam to the smallest figure. In ordinary circumstances if one increases the current supplied to the arc, the candle-power is increased, but at the same time the size of the crater becomes greater. Consequently, although the total candle-power is improved, the dispersion is also increased and there is no great gain in "maximum candle-power." With a 150 amp. arc, producing a crater 23 mm. in diam., a 90 cm. diam. mirror, with 45 cm. focus, may be used. The intensification produced by the mirror would thus be :—

$$\frac{1-\text{Cos } 45^\circ}{1-\text{Cos } 2^\circ} = 500 \text{ times.}$$

Thus an arc giving ordinarily 50,000 candle-power, would yield a beam-power of $50{,}000 \times 500$, or 25,000,000 candles.

In order to produce a substantial advance in this figure it is necessary to produce a source of light giving equal or greater candle-power from a crater-area less than that of the present arc; this has been accomplished by cooling the outer surface of the carbon, which enables the diameter of the core to be reduced to nearly one-third for the same current. Another step has been the embodying in the core of ingredients of the type used in flame carbons.

By these means a lamp giving double the light, and a beam-divergence of only 1° can be obtained, and the intensification factor becomes :—

$$\frac{1-\text{Cos } 45^\circ}{1-\text{Cos } 1^\circ} = 1952 \text{ times.}$$

Moreover, as the candle-power produced is also approximately doubled, the useful illuminating power of the combination is increased approximately *eight* times.

Experiments have also been made with gas-filled incandescent lamps with the object of securing maximum concentration of light. The more concentrated arrangement and greater intrinsic brilliancy of modern lamps is favourable to high efficiency in the reflector. For example, by using a 6-volt 108-watt lamp (having a very compact filament), it is possible to produce a reflector giving seven times the multiplying power obtainable when using a 100-volt lamp under the same conditions. When one compares the total luminous flux reflected by most reflectors with the lumens produced by the lamp used with them, one sees that there is great scope for improvement, even in up-to-date modern reflectors.

For many purposes a very concentrated beam is not necessary, but for special purposes it is highly desirable. In his work in the Navy the author has succeeded in producing reflectors which, with a dispersion of six degrees, produce a candle-power about 1,000 times that of the original lamp.

Referring to street-lighting problems, the author laid stress on the importance of accurate control of light by reflectors. With the modern high candle-power incandescent lamps of comparatively small weight, there seems no reason why lamps of several thousand candle-power

should not be mounted as high as 16 ft. above the ground. This would be effectual both as regards direction of light and diminution of glare.

It is to be noted, however, that glare does not depend only on intrinsic brilliancy but on contrast. A motor-car head-light is considerably more glaring than an arc lamp of the same candle-power in an opalescent globe, because in the latter case the brightness gradually diminishes from the centre to the periphery, while in the former we pass suddenly from brightness to darkness.

THE "LAMBERT": A NEW UNIT OF BRIGHTNESS.

Readers of American literature on illuminating engineering have no doubt perceived the appearance of a new unit, recently adopted in that country for the specification of brightness value, the "lambert," and it occurred to us to give the definition of this term. A lambert is the brightness of a surface which emits one lumen per square centimetre of radiating surface. The term can be applied both to surfaces which produce light (such as the flame of a candle, an incandescent mantle, or a globe-screened electric lamp) or to surfaces which receive light and become luminous by reflection. Thus a perfectly reflecting and diffusing surface, following Lambert's cosine law exactly, which received one lumen per square centimetre, would have a brightness of "one lambert." In practice there are no such surfaces. Therefore, when one speaks of an illuminated area as having a brightness of so many lamberts one means that it has a brightness equivalent to that of an ideal reflecting surface receiving one lumen per square centimetre. The ordinary gas flame has a brightness of about one lambert; this is about 7 per cent. less than a surface-brightness of one foot-candle.

SELENIUM CONTROL OF TORPEDOES.

In the *Electric World* some time ago* the suggestion was made that torpedoes might be automatically directed to follow and sink warships carrying search-lights, by means of selenium cells. Mr. B. F. Meissner has constructed an "electric dog," *i.e.*, a small vessel on rollers whose mechanism is controlled by a selenium cell and which follows the beam of a small hand-lamp carried about the room. It is suggested that in night operations a selenium-controlled torpedo might react in a similar manner to the beam of a distant search-light, so that any ship using a search-light to detect submarines would automatically bring about its own destruction.

* May 1st, 1915.

SYNTHESIS OF COLOURS BY THE THREE-COLOUR METHOD.

It is well known that there are available instruments for accurately analysing, according to an arbitrary scale, the colour of different glasses and fabrics, and in Germany an instrument was brought out some time before the war which, by the rotation of one of a pair of Nicol prisms, between which is placed a piece of quartz, enables any desired tint to be reproduced.

A simple apparatus for the same object has been produced in the United States by Mr. M. R. Pevear.* It employs a combination of three 40-watt lamps in front of which are placed respectively sheets of red, green and blue glass. The combined light from the three lamps illuminates a white surface, and each lamp is controlled by a separate rheostat. By this adjustment a wide range of complex colours can be produced and any desired tint exactly matched. The same principle has long been employed for the production of colour-effects in stage lighting, and in a compact form the apparatus would no doubt be useful in trades concerned with coloured fabrics.

* *Elec. World*, Feb. 13th, 1915.

THE PROPER METHODS OF COMPARING GAS AND ELECTRIC LAMPS.

COMPARISON ON A LUMEN BASIS.

AN article by G C. Shadwell in the American Gaslight Journal for Jan. 31st 1916, points out some of the sources of uncertainty in the comparisons often made between gas and electric light as commonly made. Such comparisons are inevitably much affected by local circumstances. The conditions which decide a consumer to use gas in preference to electricity or vice versa often include many factors which cannot conveniently be introduced into a pure comparison of cost.

But it is at least desirable that cost-comparisons should be conducted on lamps of about the same intensity and should be free from avoidable ambiguities. For example, both in the case of gas and electric lamps, the candle-power is often assumed in some particular direction, without considering whether the comparison will hold good for the light at other angles. The author therefore suggests that comparisons should be made on the basis of the total output in lumen-hours during a specified period. It is also proposed that the quality of gas used should be specified and that gas lamps should be rated on the basis of "lumens per B.Th.U. per hour."

In order to illustrate his method the author makes a comparison of two lamps, one described in the Proceedings of the Am. Gas Institute for 1912 (p. 322), the other an electric incandescent lamp of about the same candle-power described in "Engineering Data" of the General Electric Co. (U.S.A.) April, 1915. The comparison works out as follows:—

The small upright burner gas lamp was used with water-gas (0·717 s.g.) giving 632 B.Th.U's. per cubic ft. Other data available are:—

Pressure.	Consumption.	M.S.C.P.	Lumens.	Lumens. per B.Th.U. per hr.	Lumens. per cub. ft. per hr.
2·5 in.	1·21 cub. ft. per hr.	27·0	338·8	0·443	296·6

The electric lamp (multiple tungsten inct.) is described as follows:—

Volts.	Watts.	M.S.Cp.	M.S.C.P. per watt.	Lumens.	Lumens. per watt.
105—125	40	30·4	0·76	381	9·52

Assuming the cost of gas to be 1 dollar (4s. 2d.) per 100 cub. ft., and the electric energy to cost 0.1 dollars (approx. 5d.) per unit, the costs for the two lamps will be:—

Electric lamp, cost per lumen per hour=

$$\frac{0{\cdot}1\times 1}{9{\cdot}52\times 1000}=$$

·0000105 dollars (=0·0002d. approx.)

Gas lamp, cost per lumen per cub. ft per hr.=

$$\frac{1}{296{\cdot}6\times 1000}=$$

·0000034 dollars(=·00007d. approx.)

The ratio of costs is therefore approx. 3 : 1.

Naturally the assumptions made would not necessarily apply in this country, (where the costs of gas and electricity are different), and apart from this it should only be regarded as applying to the units in question and not to gas and electric lighting generally.

LIGHT-REFLECTING VALUES OF WHITE AND COLOURED PAINTS.

A PAPER on this subject by H. A. Gardner recently appeared in the *Journal of the Franklin Institute* (Jan., 1916). The difficulty in estimating the reflecting power of coloured materials lies, not only in the colour-difficulties inevitably involved in a comparison with white light, but also in the complexities introduced by surfaces which are not matt, but more or less glossy. Such surfaces appear to have a different reflecting value according to the angles from which they are viewed, and the best method would appear to be to take note of the light reflected in all directions.

In order to accomplish this result the author makes use of the following arrangement. A disc 3¼ in. diameter, coated with the paint in question, is placed at the centre of an integrating sphere (Ulbricht globe) and illuminated by the light of a concentrated filament lamp shining through an opening in the top of the sphere. The light fell on the disc at an angle of 45 degrees. Practically all reflected light is received by the walls of the sphere and is measured by means of an observation window in the usual way.

For the purpose of standardisation such surfaces are compared with an arbitrary standard white material. For this purpose a block of magnesium carbonate is used, the comparison being effected by substituting this for the surface to be tested within the globe. The coefficient of reflection of this material was found by Nutting, Jones and Elliott to be 88 per cent.*

Using this figure as a basis the author finds the following values for the reflecting power of various pigments used for colouring walls :—

Colour.	*Coeff. of reflection.* per cent.
White Standard (Mag. carbonate)	**88**
Light cream	66
Light pink	60
Light Yellow	58
Light blue	55
Light greenish yellow	54
Light buff	52
Light green	42
Light terra-cotta	41
Medium terra-cotta	39
Light greenish blue	36
Medium blue	32
Warm green	19
Medium green	14
Red	12
Blue, dark	12
Green	11

The value of this determination is increased by the fact of the author giving, side by side with the above figures, an inset on which actual coloured samples of the materials tested are attached.

* Trans. Ill. Eng. Soc. U.S.A., Vol. 9, No. 7, 1914.

ENGINEERING STANDARDS COMMITTEE.

At its main meeting on Friday, July 14th, 1916, the Engineering Standards Committee passed two Resolutions placing on record their deep sense of the loss sustained by them, and by the Engineering Industry generally, in the tragic deaths of Sir Frederick Donaldson and Mr. Leslie S. Robertson.

Sir Frederick Donaldson rendered extremely valuable services to the cause of Engineering Standardisation, especially in his capacity as Chairman of the Sectional Committee on Screw Threads and Limit Gauges.

In the death of Mr. Leslie S. Robertson the Engineering Standards Committee has lost an able and energetic secretary, and the Committee recognise that the movement owes a very deep debt to the ability he brought to bear upon many difficult problems, which arose in the course of its growth.

A YEAR'S PROGRESS IN ILLUMINATING ENGINEERING.

A Report presented by the Committee on Progress (Mr. F. E. Cady, *Chairman*, Mr. T. J. Litle, Mr. L. B. Marks, Mr. T. W. Rolph), at the Ninth Annual Convention of the Illuminating Engineering Society, held in Washington, September 20th to 23rd, 1915; slightly abbreviated.

(*Continued from Vol. VIX., March* 1916, *p.* 106.)

Street Lighting.

Display Lighting.—A general survey of the progress in the lighting of streets shows that there has been a decided increase in ornamental lighting[92] for advertising purposes, so-called "White Way" lighting. Among the cities where such installations have been made during the past year may be mentioned Portland, Ore.,[93] where a system has been placed on one of the business streets consisting of crossed structural steel arches bridging the crossings and supported on concrete columns. Each of these arches is outlined by 192 incandescent lamps placed on the under side. "White Way" lighting has also been installed in Newark,[94] N.J., using lamps of 500 candlepower; in Louisville,[95] Ky.; in Lowell,[96] Mass., where 234 magnetite 6.6-ampere arc lamps have been used, placed 14.5 ft. (3.20 m.) above the sidewalk and with a maximum distance between units of 120 ft. (00.00 m.) and a minimum of 50 ft. (15.24 m.), lamps being located as far as possible on alternate sides of the streets; in Union,[97] N.J., where 40 gas-filled 500-watt tungsten lamps were used; in Paterson,[98] N.J.; in Sioux Falls,[99] S.D., where 156 luminous arc 6.6-ampere lamps have been placed six to the black in a staggered arrangement; in Sandusky,[100] O., where 14 city blocks are involved and 380 gas-filled tungsten lamps of 250 candlepower each are mounted on two-light standards approximately 50 ft. apart; furthermore a complete lighting system for the city is being installed consisting of 920-60 candlepower and 100 candlepower lamps of the same type; in Cleveland, where 600 gas-filled 20-ampere tungsten lamps are mounted on standards with a special type of glassware consisting of a refractor to give the desired distribution of illumination, and an enclosing globe with roughened surface which is designed to have a pleasing appearance without materially changing the distribution due to the refractor; in Charleston, W. Va.,[101] where 62 ornamental luminous 4-ampere arc lamps have been installed; at Malone, N.Y.,[102] where 400-candlepower gas-filled tungsten lamps mounted on ornamental posts were installed; at St. Cloud, Minn.,[103] where the number of arc lamps was increased to 100 and changed to the luminous or magnetite type.

There is[104] a tendency away from the use of five-lamp standards for a "White Way" lighting inasmuch as they are too prominent in the daytime. Preference to-day inclines toward a single or at most a double-light unit with a comparatively high candlepower lamp. The introduction of the gas-filled tungsten street series unit has, in general, resulted in increasing[105] the candlepower used and not in decreasing the wattage. In addition to the improvement in efficiency the new construction has made possible an extension in the range of candlepowers available thus giving greater

91 *N. E. L. A. Bul.*, May, 1915, p. 340.
Elec. World, Mar. 27, 1915, p. 805.
92 *Municipal Jour.*, June 24, 1915, p. 886.
93 *Pop. Mech.*, July, 1915, p. 101.
94 *Elec. Rev. and W. E.*, Nov. 14, 1914, p. 954.
95 *Elec. Rev. and W. E.*, Nov. 14, 1914, p. 954.
96 *Elec. Rev. and W. E.*, June 5, 1915, p. 1039.
97 *Elec. World*, June 26, 1915, p. 1697.
98 *Municipal Jour.*, May 27, 1915, p. 740.
99 *Light. Jour.* (U.S.), May 1915, p. 98.
100 *Elec. Rev. and W. E.*, May 22, 1915, p. 963.
101 *Municipal Jour.*, July 22, 1915, p. 114.
102 *Elec. Rev. and W. E.*, July 31, 1915, p. 180.
103 *Municipal Jour.*, May 27, 1915, p. 729.
104 *Elec. World*, May 22, 1915, p. 1328.
105 *N. E. L. A. Bul.*, Mar., 1915, p. 171.

flexibility to this type of lighting. The feasibility of replacing arc lamps with incandescents for street lighting has been agitated ever since the introduction of incandescent units of sufficient intensity to produce comparable results. The question has been re-opened since[106] the introduction of the high candlepower tungsten lamps. Numerous tests have been made and reports given on the relative merits of the two types of illuminants and on the relative cost of operation. But there are so many factors entering into the problem that it seems increasingly difficult to draw even general conclusions.

[After this there follows an account of the lighting arrangements adopted in various American cities (with reference Nos. 107—121), which restrictions of space compel us to omit. ED.]

Investigations.—The investigation of street lighting being carried on under the joint auspices of committees of the National Electric Light Association and the Association of Edison Illuminating Companies and which was started last year is[122] still uncompleted. To properly interpret results already obtained requires a complete knowledge of the conditions and no attempt will be made to summarise them in this report. Another investigation of the factors connected with effective illumination of streets has been directed toward a study of the effect of glare on visual acuity. The method[123] of test consisted in making observations of a special visual acuity test chart first with the street lamps off and then under ordinary lighting conditions. Among the conclusions reached were that merely surrounding a brilliant source of light by a diffusing globe does not materially diminish blinding effects. Mounting heights less than 20 ft. (6.09 m.) should be avoided if possible and heights less than 15 ft. should never be employed. When the height is relatively low the candlepower between the angles of 65° and 90° from the vertical should also be relatively low. So far as avoidance of glare is concerned there is no object in increasing the height beyond 50 ft. (15.24 m.).

Other Exterior Illumination.

The continued improvement in illuminants is reflected in the spread of outdoor-lighting of all kinds and the use of light more than ever before for a variety of purposes. Thus a real estate dealer arranges to have a new sub-division highly illuminated[124] and rapidly sells his lots to customers who have come out to view them at night. Improvements in distance lighting and control[125] have made feasible the employment of gas in places where its use had previously been considered impossible. A big extension is to be noted in the use of light for exterior advertising purposes.

Flood-lighting.—One of the most striking illustrations of the modern "flood-lighting" method of illuminating the exterior of buildings is to be found in the lighting of the Woolworth building[126] in New York City, which was disclosed to public view at the beginning of the year. It has been said that more light is provided for the illumination of the tower than is usually employed in lighting a city of 30,000 inhabitants. 600 automobile projector units fitted with 250-watt, gas-filled tungsten lamps are used to throw light on the structure from the thirtieth to the fifty-eighth storey. These projectors are arranged so that some throw their light upward and the rest throw their light downward. Thus there is one continuous diffusion of light over the whole surface. The lamps throwing light downward are carefully screened so as not to be directly visible from the street. The most novel point of the installation, however, is at the sixtieth storey called the "crow's-nest" or "lantern." It has been enclosed with diffusing glass and within are placed twenty-four 1,000-watt lamps. An auto-

[106] *Jour. f. Gas.*, Aug. 1, 1915, p. 777.
Elec. World, June 19, 1915, p. 1594.
Ibid., July 10, 1915, p. 109.
Elek. u. Masch., Feb. 7, 1915, p. 73.
Elek. Zeit., June 3, 1915, p. 269.

[122] TRANS. *I. E. S.*, 9, 1914, p. 536.
Report of Committee on St. Light. *N. E. L. A.*, June, 1915. See also TRANS. *A. I. E. E.*, July, 1915, p. 1379

[123] *Elec. Rev. and W. E.*, Mar. 6, 1915, p. 439.

[124] *Elec. Rev. and W. E.*, May 8, 1915, p. 856.

[125] *Gas Age*, July 1, 1915, p. 5.

[126] *Elec. Rev. and W.E.*, June 5, 1915, p. 1048.

mobile dimmer connected with these lamps continuously alters their intensity in an irregular cycle. Thus at one instant the glass surface of the lantern shows a deep red glow no brighter than the adjacent gilded structure, and again it flares up to a bright white light many times this brightness and visible for miles.

The flood-lighting idea has been much extended in[127] the illumination of advertising signs on billboards, water tanks, roofs of buildings, side walls and elsewhere. In such cases the effect is accomplished by directing a beam of light against the sign from some near-by convenient location, and a new lighting unit of high intensity utilising a parabolic reflector has been recently developed for this special purpose.

Lighting of Sports.—The lighting of courts for tennis and other sports has proved so satisfactory that the idea is being tried out in a number of different ways. A playground in a city park has been illuminated so that[128] its various amusements are available at night as well as by day. Five 750-watt, gas-filled tungsten lamps are used to light the football field while 1,000-watt units are used to illuminate the swings and gymnasium apparatus. These units are placed 20 ft. (6.09 m.) above the ground on goose-neck boulevard posts. A test was made at the Indiana State Fair grounds recently of[129] a system of illumination, in order to try out the practicability of automobile racing at night. The result was a complete success. Lights of the type used in contracting and railroad work for emergency operations at night, were placed at intervals about the track. Each light was supplied from its own cylinder of dissolved acetylene. In another case[130] an outdoor skating rink used for the sport of curling has been lighted by tungsten lamps installed on two lines of stray wires, extending the length of the rink, and about 35 ft. (10.66 m.) apart. Extra illumination is furnished at the ends over the goals. The lamps hang about 15 ft. above the surface of the ice.

A sign of progress[131] is to be noted in the installation of a lighting system on the celebrated wall which surrounds the block in Salt Lake City enclosing the famous Tabernacle and Temple. The wall is approximately 12 ft. (3.65 m.) high and will be lighted by high power lamps located every 50 ft. (15.24 m.).

Because of the scarcity of kerosene there has been an extension of gas and electric lighting in Germany,[132] alcohol and acetylene being adopted in the country districts.

Interior Illumination.

The trend in interior lighting continues to be in the direction of protecting the eyes from excessive brightness.

Hotel Lighting.—A recently finished, and[133] what is claimed to be largest hotel in Europe, has been fitted throughout with the semi-indirect system of illumination. The lighting has been so arranged that corridor lights are independent of those in adjacent bedrooms. In the dome of the rotunda court a novel plan has been adopted of introducing opal bulls-eyes with a lamp behind each, into the risers which support the glazing of the dome. Around the dome cornice is a ring of lamps which are concealed from view at the floor level but throw a considerable volume of light upward into the dome. Some 6,000 lamps are used in this hotel. In England[134] the use of high pressure gas is being extended to factory lighting.

Municipal Buildings.—While a private enterprise is quick to see and adopt improvements in lighting sources and methods, the municipally controlled institution has in the past exhibited a decided inertia in this respect. A start has been made in Boston[135] to remedy this and the replacement of old types of lamps of low efficiency has already brought about a marked saving to the city. The change has been so satisfactory that one of the city engineers is to devote his entire time during this year to improving the lighting of buildings in the school, police and fire departments.

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127 *Elec. Merchandise*, Dec., 1915, p. 306. See also *Cent. Sta.*, May, 1915, p. 346.
128 *Elec. World*, May 22, 1915, p. 1328.
129 *Sci. Amer.*, June 12, 1915, p. 587.
130 *Elec. Rev. and W.E.*, Feb. 13,1915.,p.311.
131 *Elec. Merchandise*, Apr., 1915, p. 82.
132 *Pop. Mech.*, May, 1915, p. 651.
133 *Elec. Times*, June 24, 1915, p. 531.
134 *Jour. of Gas Lt.*, June 1, 1915, p. 506.
135 *Elec. World*, May 22, 1915, p. 1327.

Office Buildings.—Heavy glass partitions which are translucent, substantial, sun-proof, and fire-proof, are being introduced, as a[136] means of distributing sunlight through large office buildings, without lessening the privacy of the various offices. These partitions are built of clear glass units, 2 in. (50.80 cm.) thick, and either 6 or 8 in. square, which are reduced to translucency by impressed designs.

Hospitals.—That the educational work of the Society on the subject of colour and glare is bearing fruit, is seen in the use of green and buff for the colour of the walls in a large Western[137] hospital. White had always been used, but it was found, on trial, that the discomfort coming from the necessity of eye-adaptation on the part of surgeons looking up from their work, and seeing only white-clothed assistants and white walls was largely eliminated with the use of other colours. The effect on patients has also been beneficial. In another large city hospital a rather unique use of the mercury vapour lamp is found in its employment[138] for examination of X-ray skyographs.

Street Railway Cars.—A growing recognition of the importance of proper lighting in every sphere of activity is illustrated in the[139] recent extensive tests conducted by a large municipal railway. A full sized template car was built and tested when equipped with direct, semi-indirect, and totally indirect systems of lighting. The general effect and appearance of each system under test were judged by comparison with present methods of car lighting for similar service. The effect of the light on the eyes was particularly noted by a large number of observers. The system finally adopted consists of a single row of 56-watt, bowl-frosted tungsten lamps placed symmetrically down the centre line and equipped with opal glass reflectors. The above lamps were supplemented by six 10-watt, all-frosted round bulb tungsten emergency lamps. One big unit was placed on each end-bulkhead of the car to bring up the illumination at these points. In the car as finally equipped the illumination averaged 5.94 foot-candles, at normal and 3.85 at 85 per cent. voltage, the energy consumption was 1.44 watts per square foot, effective lumens per watt 4·14 and the utilised efficiency 50.6 per cent.

Another street railway company is emphasising[140] the "Safety First" principle by providing a light so placed as to directly illuminate the step of the street car. A practical application of signal lights has been adopted by[141] some of the theatres of Vienna. On the back of each seat is a small electric lamp which illuminates the seat number. As long as the seat is turned up, as it usually is when not occupied, the light is burning, but is shut off when the seat is turned down. By this means the use of ushers has been materially decreased.

Clock Tower.—A novel use for the method of indirect lighting is to be found in the illumination of clock dials in the new Boston Custom House.[142] Behind each dial is a chamber with white walls illuminated by a number of lamps. Numerals of the dial are in the form of slots set in concrete and the lights in each chamber are so arranged that no unreflected light passes through the slot. The effect is to make each numeral appear as if cut out from a piece of uniformly lighted paper.

An application of the "flood-lighting" idea was made[143] recently at one of the automobile shows where a machine was brilliantly illuminated by lights in two ornamental troughs hung by chains about 8 ft. from the floor, and 9 ft. (2.74 m.) in front of the car.

The art-glass dome is ordinarily associated only with the lighting of dining-rooms, but it has been added[144] to the long list of illuminants used to produce an attractive show window illumination.

(*To be continued*)

136 *Pop. Mech.*, June, 1915, p. 818.
137 *Pop. Elec. and Mod. Mech.*, Dec., 1914, p. 644.
138 *Elec. World*, June 5, 1915, p. 1475.
139 TRANS. I. E. S., 1915, p. 227.
140 *Elec. Ry. Jour.*, Jan. 30, 1915, p. 247.
141 *Pop. Mech.*, Apr., 1915, p. 568.
142 *Pop Mech*, July, 1915, p. 75.
143 *Elec. World*, May 15, 1915, p. 1255.
144 *Elec. World*, May 22, 1915, p. 1315.

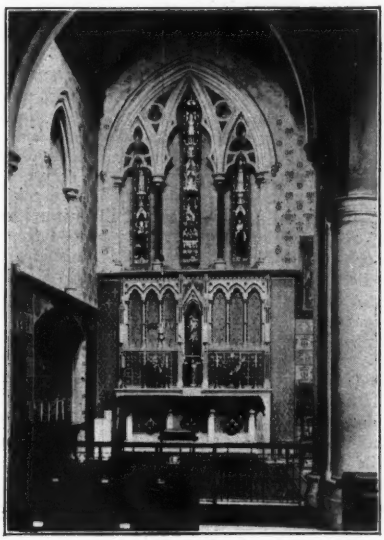
TOPICAL AND INDUSTRIAL SECTION.

[At the request of many of our readers we have extended the space devoted to this Section, and are open to receive for publication particulars of interesting installations, new developments in lamps, fixtures, and all kinds of apparatus connected with illumination.

The contents of these pages, in which is included information supplied by the makers, will, it is hoped, serve as a guide to recent commercial developments, and we welcome the receipt of all *bona-fide* information relating thereto.]

CONCEALED LIGHTING IN A CHURCH.

The illustration shows an interesting method of lighting employed in the Sacristy of St. Mary's Church, Croydon. The illumination is derived from three Holophane reflectors of special type, which carry spiral tungsten filament lamps, the whole being arranged to give a highly concentrated downward light. The units are mounted directly behind the arch at the exceptional height of 20 ft. This has the effect of making the altar stand out prominently, and the restful effect is well adapted to church lighting. The illumination on the altar was found to be 2 to 2·5 foot-candles. A similar arrangement is used for illuminating the choir and organ, but in this case the illumination value is higher, namely, 5 to 6 foot-candles.



Effect of concealed lighting with tungsten lamps and Holophane reflectors in the Sacristy of St. Mary's Church, Croydon.

The whole of this Church is lighted throughout with Holophane units. Five-light fittings, with 60 watt lamps and Holophane extensive type reflectors are used to illuminate the main body and single pendants with 100 watt lamps and intensive type reflectors are used for the side aisles. The illumination on the reading plane in these sections is stated to be 2 to 2·5 foot-candles.

For the above information and photograph (the latter having been taken by artificial light), we are indebted to Holophane, Ltd.

GAS LIGHTING IN A PHILADELPHIA CATHEDRAL.

A PAPER describing the lighting of the Cathedral of SS. Peter and Paul in Philadelphia was recently read before the Illuminating Engineering Society (U.S.A.) by Mr. James D. Lee, of the United Gas Improvement Co. (of that city), to whom we are indebted for the accompanying two photographs of the installation. We observe that these photographs appeared in an article in the December issue of *New Business*. An account of the installation is also given in the *Gas Age* for April 1st, from which the following particulars are taken.

The illustrations suggest that the installation is of an interesting example of what can be done by modern gas units of a decorative type. The production of artistic gas fittings, particularly those of the semi-indirect type, has made considerable headway in this country (it will be recalled that some good illustrations of semi-indirect lighting were shown at the National Gas Exhibition in 1913), and while these aspects of lighting are inevitably overshadowed by more important work during the war, we look for continued development in the future.

It will be seen that the chief element in this particular installation is the production of soft diffused illumination effects, such as are naturally suited to a cathedral. The fittings are of the semi-indirect type, which is effective for illuminating the surroundings and showing up the architectural features of the building. The units are so arranged that the congregation have a clear and unobstructed view of the main altar; and the reflected light from the arches, besides giving a pleasing impression, is helpful in diffusing the general illumination. The complete installation comprises twelve fixtures (six with fifteen mantles and six with twelve mantles per fixture), conforming in design to the period of the architecture of the church. The fixtures are of massive construction, but so designed as to give no impression of clumsiness and to harmonise with the building. Each fixture weighs about 200 lbs. The piping is quite inconspicuous, and the control of the lamps is effected by a chain pull and pilot.

The lighting is so arranged as to be serviceable for all occasions requiring artificial light. Thus at the early morning services the two fixtures on either side of the altar, the two at the back of the transept, and the two forward in the nave are used. On Sunday all fixtures are lighted from 4.30 a.m. until 12.30 noon on dark days. The full lighting is also used for all evening services. Two fixtures are found to suffice to enable people to find their way about in comfort.

Experience shows that with burners of the horizontal type employed 2.75 cub. ft. of gas per mantle are required, and approx. 315 lumens per cub. ft. of gas per hour obtained.

A very careful study of the conditions of brightness giving the best effect was made, and the following particulars are given by Mr. R. F. Pierce, of the Welsbach Co. :—

A. 0·00185 c.p. per sq. in., arches of chapels.
B. 0·00185 c.p. per sq. in., domes of chapels.
C. 0·306 c.p. per sq. in., ceiling of nave.
D. 0·301 c.p. per sq. in., brightness of dish.
E. 0·256 ft.-candles, transept, first front pew.
0·338 ft.-candles, transept, midway to fixture, directly underneath.
F. 1·74 ft.-candles, directly beneath unit No. 5 (15 mantles).
G. 1·37 ft.-candles.
H. 1·04 ft.-candles.
I. 1·04 ft.-candles.
J. 0·00088 c.p. per sq. in., brightness of altar.
K. 0·000095 c.p. per sq. in., brightness of darkly painted walls.
L. 0·0000 c.p. per sq. in., brightness of main altar.
M. (1) 0·22, transept middle aisle, front pew.
(2) 0·26 transept middle aisle, midway.
N. 0·58 ft.-candles, nave middle aisle, between units 4 and 9.
O. 0·38 ft.-candles, transept middle aisle, front pilaster.
P. 0·58 ft.-candles, nave middle aisle, between units 3 and 10.
Q. 0·58 ft.-candles, nave middle aisle, between units 2 and 11.
R. 0·475 ft.-candles, nave middle aisle, under organ loft.

It is remarked that the soft nature of the lighting conditions enables a lower illumination to suffice than if the lighting were of a glaring character. The arrangements have evidently been the subject of careful forethought and scientific design, and this doubtless accounts for the success of the installation.

A GAS DISPLAY IN JANESVILLE (Wis. U.S.A.).

WE notice, in *New Business*, an account of the gas display at a recent "Made in Janesville Week" at the city of that name.

Great efforts were made to render the display attractive, both as regards the use of gas for heating and cooking, and for illumination. In lighting the various stalls semi-indirect methods played a conspicuous part.

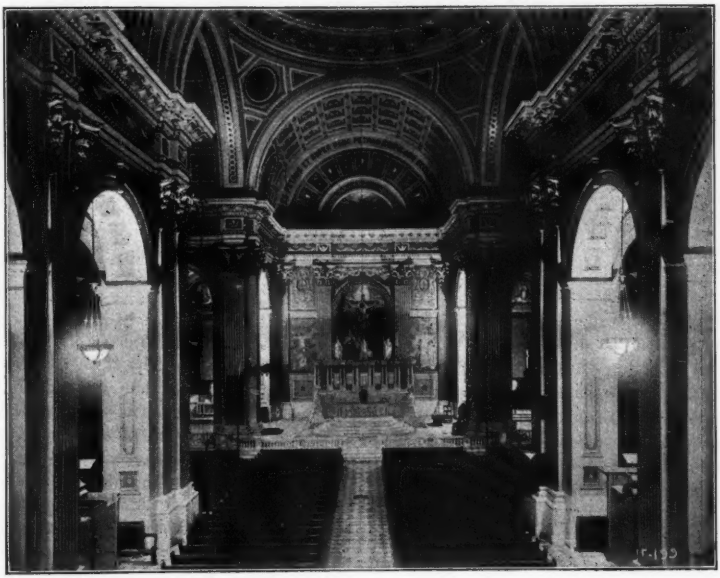


FIG. 1.—Night photograph, showing semi-indirect gas lighting in the Cathedral of SS. Peter and Paul, Philadelphia ; looking towards the main altar.

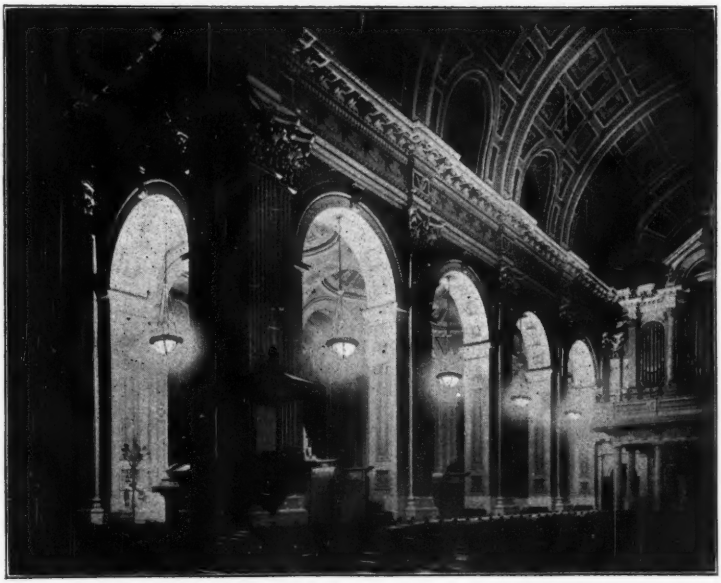


FIG. 2.—Another view showing the effective side-lighting of the Cathedral.

PETROL AIR GAS FOR COUNTRY LABORATORIES.

A note on this subject appeared in our last issue, and we have now received particulars of another system, the "Willett Light," which we understand is specially adapted to the lighting and heating of country laboratories.

The Willett generator is driven by weights, the rate of revolution is low, and all the essential parts are constructed of brass or copper—all items which make for simplicity in operation and durability of the plant. In common with the best modern plants, the Willett system is stated to be entirely automatic, the quality of gas being maintained constant irrespective of the number of lights turned on. Another feature is that gas is produced from ordinary No. 1 motor-car spirit, easily obtainable in the most remote districts.

While readily applicable to lighting country houses, farms, churches, &c. dairies, cow-houses and out-buildings of various kinds, the application of the system to laboratories where heating as well as lighting is commonly required, is of special interest at the present time. While for ordinary lighting purposes petrol of 0·720 specific gravity (ordinary motor car spirit) is advised, and a mixture of 1½—2 per cent. of petrol with 98½—98 per cent. of air used, a somewhat richer mixture is desirable for laboratory purposes. In this case spirit of 0·680 specific gravity is preferred.

In this way a gas is produced which can be used as readily as coal gas for bunsen burners, blow-pipes, muffle furnaces, &c. In the case of country laboratories, having no gas-supply available, this is obviously an important point which will have a decided influence in determining the form of lighting to be adopted. We are informed that among the laboratories that have used this system include: The Royal Naval Air-ship Station Experimental Laboratory, the laboratories of H.M. Ministry of Munitions, Messrs. Kynoch-Arklow, Ltd., Nobel's Explosive Co., Distington Iron Works, the Ammonia Soda Co., Ltd., &c.

The system may be seen in operation and all additional particulars obtained at W. Willett's showrooms at Sloane Square. Booklets descriptive of the system will be sent post free on request.

BOARD OF TRADE ANNOUNCEMENT.

Coal Supplies.

A circular issued by the Board of Trade on the subject of Coal Supplies draws attention to the following Regulation made by Order in Council under the Defence of the Realm Acts on June 27th:—

"2D. It shall be lawful for the Admiralty or Army Council or the Minister of Munitions, or any person authorised by them to act in their behalf, after consultation with the Board of Trade, to give directions as to the priority to be given in the execution of orders or contracts for the supply of coal or coke, with a view to securing precedence for orders or contracts in accordance with their national importance, and the owner, agent or manager of any mine or any other person affected by the directions who fails to comply with any directions so given, and any person who in any certificate or document given or issued for the purpose of securing priority for any order or contract in pursuance of such directions makes any false statement or false representation, shall be guilty of an offence against these Regulations."

In addition, Section (2) of the Defence of the Realm (Amendment) No. 2 Act, 1915, provides that:—

"where the fulfilment by any person of any contract is interfered with by the necessity on the part of himself or any other person of complying with any requirement, regulation, or restriction of the Admiralty or the Army Council under the Defence of the Realm Consolidation Act, 1914, or this Act, or any regulations made thereunder, that necessity is a good defence to any action or proceedings taken against that person in respect of the non-fulfilment of the contract so far as it is due to that interference."

While the existence of these Orders is pointed out, it is stated that the work of the District Coal and Coke Supplies Committees has hitherto been carried on by general consent, and it is hoped that few cases will arise in which it is necessary to use the powers conferred.

"FLOOD-LIGHTING" IN THE UNITED STATES.

View by day.

View by night.

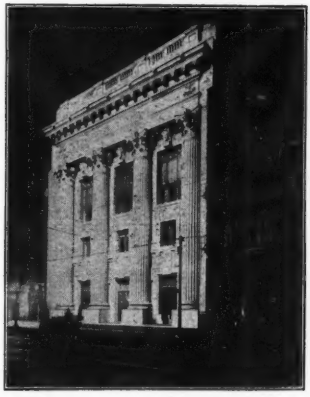
Night and day views of a large 35 × 70 ft. sign in Indianapolis (U.S.A.), showing effect of artificial "flood-lighting."

In a recent number of THE ILLUMINATING ENGINEER* we reproduced a view of the Woolworth Building Tower in New York, which is illuminated by concealed projector lamps. The accompanying views shows some other examples of this method of lighting, kindly sent to us by the National X-Ray Co. of Chicago, which show the striking effects obtainable. It is stated that by the aid of these specially designed focusing reflectors, and with lamps of appropriate concentrated filaments, an equivalent candle-power of as much as 67,000 can be obtained by an expenditure of only 250 watts.

One of the illustrations shows the application of this system of "flood-lighting" to the frontage of an imposing Cleveland bank. The other views illustrate its utility for sign lighting. It has often been pointed out in these columns that there are great possibilities in concealed lighting for exhibition and spectacular purposes, and that such methods, which comply with the fundamental principle of "light on the object, not in the eye," are often much more effective than the practice, so common in the past, of outlining signs and buildings with clear bulb electric incandescent lamps.

In the present circumstances, spectacular lighting is naturally inapplicable in this country. But it is still well worth while to study its possibilities with a view to development after the termination of the war. Apart from its utility for signs and for advertising purposes, it is also conceivable that, carefully applied, it would have a genuine use for displaying the architectural features of buildings. One point, however, requires to be remembered. In most of these American cities the atmosphere is presumably comparatively free from smoke, and the surfaces of buildings do not so readily assume the sooty appearance common in London and other large European cities. It remains to be seen, therefore, how far the comparatively low-reflecting value of the surfaces of many of our buildings would interfere with the application of concealed lighting.

It is also possible that, even in the present circumstances, concentrating units of this kind would have useful applications for military work. We understand that the British Thomson-Houston Co., Ltd., are sole agents for the development of the X-Ray appliances in this country.



The First National Bank, Cleveland (U.S.A.), lighted by 24 X-ray projectors from a building across the street.

* April 1916, p. 145.

REVIEWS OF BOOKS.

Occupations, from the Social, Hygienic and Medical Points of View. By Sir Thomas Oliver, M.A., M.D., LL.D. (Cambridge University Press, Public Health Series. 1916. 110 *pp.*)

SIR THOMAS OLIVER is an acknowledged expert on this subject, which is of absorbing interest.

In the introduction to this volume he traces the gradual evolution in industry following the introduction of machinery. The old cottage handicrafts have disappeared. Modern conditions of work are more strenuous and exacting and less healthy. The monotony of factory life tends to dwarf individuality and develops a special form of mental depression which leads to a longing for excitement and recreation unknown in past centuries. The investigation and gradual removal of these defects offer one of the most important fields for study open at the present time.

The book deals in turn with various factors prejudicial to health, each point being illustrated by striking examples. Readers cannot fail to be impressed by the evidence supporting many of the contentions of experts on industrial hygiene, and to appreciate that these are not matters of conjecture, but the result of actual observation of facts.

The initial chapters deal with the air breathed in town and factory. It is now recognised that pulmonary diseases are closely related to the presence of infected dust. Street-dust frequently contains tubercle bacilli, and a case is mentioned in which tarring the roads adjacent to a factory was followed by a diminution in the average sick rate from 30 to 12 per cent. In special trades where the dust from glass, stone, and iron is prevalent phthisis is common. In the Rand Mines the problem is particularly grave (rock-drillers, it is said, rarely survive more than 6—7 years occupation in this work), but matters have been improved as a result of precautions introduced by the S African Government on the advice of the author.

Sir Thos. Oliver also gives some interesting tables, illustrating the death- and sickness-rates in various occupations. Agriculture proves to be one of the healthiest employments. The comparative mortality in file-making, a very unhealthy occupation, is three times as great, and the relatively high rates in glass making, lead working, cutlery, and other trades gives some idea of the constant waste of life and health in industry that has to be made good.

Yet, it is interesting to notice, the unoccupied do not escape—indeed their mortality greatly exceeds that of the workers in average trades, chiefly owing to the prevalence among them of respiratory and nervous diseases. This seems to suggest—what is no doubt the case—that idleness is on the whole prejudicial to health.

A striking instance of the physical deterioration caused by dangerous trades is afforded by the sulphur mines of Sicily

In this district, it is stated, the Italian Government finds it almost impossible to obtain conscripts.

The author also dwells on the effects of rush and "speeding up" in causing accidents and inducing fatigue. He reproduces Haegler's curve, showing the course of recuperation during the night's rest, and the progressive increase of fatigue during the working week. A rest of one day in seven is fully justified on physiological grounds. Actual instances are mentioned in which persistent overtime led to a diminution in output, while shorter spells of work, with more frequent intervals for recuperation, brought about improvement, both in quality and quantity of the output.

A special reference is made to the effect of unsatisfactory illumination in causing accidents and increasing the fatigue experienced in doing skilful work. Poor lighting conditions, the author remarks, pay neither the employer nor the employed. Special importance is attached to the provision of adequate illumination for dark materials, the avoidance of glare, the proper lighting of flights of stairs, and the use of appropriate shades and reflectors.

A chapter is given up to the care of the health of workers, and some account is given of the social welfare work now being widely organised.

The book is one that may be read with profit and interest by all concerned with industrial problems, and is very opportune at the present moment when so many factories are working at high pressure.

Trade as a Science By Ernest J. P. Benn, with a Preface by Lord Burnham. (*Jarrold and Sons.* 1916. 184 *pp.*)

LORD BURNHAM, in his introductory preface to this work, acutely points out that while to-day all the world is talking of trade, "the only person who is silent about it is the tradesman." This presumably is due to the rooted suspicion of solidarity of action and "disinclination to discuss," on which Mr. Benn lays so much stress. Yet it is undeniable that the tradesman is the person most directly interested. Mr. Benn makes it quite clear that while suitable assistance from the Government in many directions might be beneficial, it is to the efforts of traders themselves, and particularly their concerted efforts in the form of Trade Associations, that we must look for the solution of the present difficulties.

Mr. Benn puts his case with moderation, and deals with the various problems in a practical way. He dwells on the exceptional financial conditions which may be expected to prevail after the termination of war, and points out that the payment of interest on accumulated debt must be met mainly by producing and selling more goods. In the past the British manufacturer has lost ground by conservative methods of manufacture, and lack of enterprise in seeking and utilising new markets, but he has always had one great asset—his reputation for honesty and the "square deal."

Most of the faults can be traced to extreme individualism—disinclination to compare experience with others in the same trade, and apathy in neglecting to form powerful Trade Associations of the kind existing abroad. Such associations as exist in this country are not truly representative, are poorly supported, and are not empowered to deal with really vital problems of real concern to the industry they represent. Mr. Benn advocates the establishments of associations on an adequate scale, able to collect information about foreign markets, investigate problems in manufacture, freight, etc., and deal directly with labour in their respective industry. Powerful bodies of this kind, however, would arouse suspicion of being "trusts," and it is therefore suggested that they should be subject to some form of Government control under a Ministry of Commerce. Government support would also be helpful in overcoming the initial prejudices of many manufacturers. The need for a Minister of Commerce has been frequently urged of late, but its functions and constitution are outlined by Mr. Benn in greater detail than by many others who have discussed the matter.

In addition to the Secretary of State for Commerce, an Advisory Council, and the Parliamentary and Permanent Secretaries, Mr. Benn suggests that there should be six under-secretaries, dealing respectively with Export, Industrial and Scientific Research, Commercial Education, Statistics and Finance, Labour, Exhibitions, and Advertising. Finally, he suggests the appointment of three hundred Trade Secretaries, whose salaries are paid half by the Government and half by the Associations they represent.

The book contains many novel and interesting suggestions, and we commend it to the notice of our readers.

Discovery, or the Spirit and Service of Science. By Prof. R. A. Gregory. (*Macmillan and Co., London*, 1916.)

PUBLIC indifference to the value of science has often been ascribed to defects in our present educational system. But a secondary explanation is no doubt to be found in the high degree of specialisation in modern scientific work, rendering it difficult for the layman to follow; and in a certain lack of skilful popular exponents, willing and able to interpret these things to a popular audience in the manner of Huxley, Tyndall and other great figures of the past century. A work like Prof. Gregory's, interesting to experts and yet capable of being read with pleasure by those who have no claim to scientific attainments, therefore fulfils a most useful function at the present time.

In the introduction the author disposes of the idea that a man of science is "a callous necromancer who has cut himself off from communion with his fellows," and protests against the conclusion, sometimes drawn by people horrified by the present world-conflict, that science is necessarily connected with materialistic domination. On the contrary the greatest men of science learned humility from their peculiarly exacting vocation and by direct contact with nature, and have done much of their best work without thought of reward.

The examples of scientific work selected by the author are taken from many fields and are designed to show the futility of the popular disposition to encourage only those varieties of work which lead to immediate practical rewards. On the contrary many of the greatest discoveries, which have had the most profound influence on social life, had no apparent applications when they were made. Faraday's work on electromagnetism, Newton's discovery of the composition of white light, the experiments of Berzelius on the rare metal thorium, are only a few links in the long chain of researches which paved the way for the practical exploitation of science to-day. Of equally far-reaching importance to mankind have been the great researches in the fields of bacteriology, anti-septic treatment of wounds, anti-toxins, &c., some of which were undertaken by the discoverers at great personal risk.

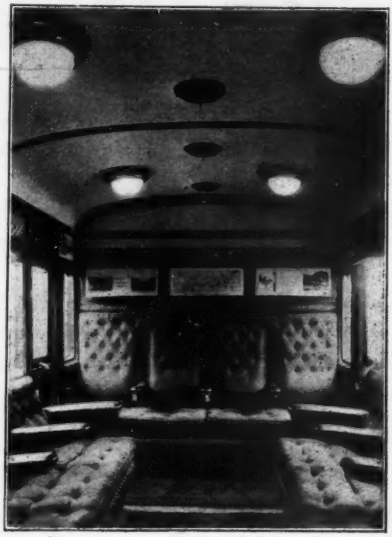
At the present time a great deal is being said on the subject of industrial research; "to the engineer the fascination of experimental research lies, as Captain Cuttle would observe, 'in the application thereof.'" But it is to be hoped that the present movement in favour of research will not be conducted entirely in the hope of immediate material gain and that we shall escape the mental attitude which led the President of the tribunal of Revolutionists to condemn to death the great chemist Lavoisier in 1793 with the cold comment, "La Republique n'a pas besoin de savants."

INDEX, July, 1916.

RAILWAY CARRIAGE LIGHTING.

In our last issue (p. 205) we reproduced an example of railway carriage lighting on the Great Central Railway by special Holophane units. The photograph now shown illustrates another installation, namely, a First Class Coach on the London and South Western Railway (Electrical Extension), which is lighted by six Holophane 10 in. Stiletto Bowls, carrying 40 watt lamps. Here again the method of mounting the units direct on the ceiling has been adopted, giving a pleasing illumination effect with the lights out of the direct range of sight and absence of glare. The minimum value of the illumination at the reading level along the seats is given as 2·5 ft.-candles.

There is no doubt that in the most modern coaches on up to date railways the conditions of illumination represent a great advance on those prevailing a few years ago, though in some cases progress is naturally limited by the present lighting restrictions.



Lighting of 1st class carriage (L. & S. W. Ry. electrical extension) with 40-watt lamps and Holophane 10 in. stiletto bowls.

PROGRESS OF ELECTRICAL ENGINEERING FIRMS.

It will be recalled that the Annual Report of the British Westinghouse Electrical and Manufacturing Co., issued a few months ago, revealed continued and substantial progress in spite of the war, and the company appears to be reaping the reward of their enterprise in applying scientific methods of training and development.

The Annual Report of the General Electric Co., Ltd., issued on July 5th, likewise shows a steady continuation of the progress of the last few years. The company's works have been largely occupied in the production of war-material, and many difficulties incidental to the war have been successfully overcome. It is interesting to note that following the appointment of Mr. J. Y. Fletcher as a director last year, three other of the younger members of the firm, Mr. M. F. Armstrong, Mr. G. H. Ide and Mr. Maurice Solomon have now joined the Board.

A considerable improvement is also recorded in the position of the British Thomson-Houston Co., whose Report was recently issued. Altogether the prospects of the leading electrical manufacturing firms appear bright and there is good reason to expect continued progress after the termination of the war.

EDISWAN ITEMS.

The Ediswan Discount tables, appearing in the form of a little pocket book, enable discounts at rates varying from 1/16 to 50 per cent. to be readily calculated on sums up to £1,000. In view of the large and varied discounts now allowed by the leading manufacturing firms the booklet should be of considerable service to those constantly engaged in quoting or estimating for installation work.

We have also received the latest list of Ediswan Electric Fans, for alternating and continuous current. A useful accessory is the Ediswan Dimmer Switch, which enables a 40-watt fan to be conveniently run at half speed.